

REMARKS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-4 are presently active in this case, Claims 1, 3, and 4 having been amended by way of the present Amendment. Claims 3 and 4 have been rejoined.

The amendments set forth herein do not raise new issues on the merits of the application, but rather merely include the changes suggested in the outstanding Official Action.

The disclosure was objected to because of minor informalities. The specification, including the written description, abstract, and claims, has been amended as suggested pages 2-4 of the Official Action. Accordingly, the Applicant requests the withdrawal of the objection to the disclosure.

The Applicant has attached hereto a copy of the "Lecture Manuscripts" noted on page 2 of the specification and a translation thereof as requested by the Examiner.

Claims 1-4 were objected to for minor informalities. The claims have been amended as suggested in the outstanding Official Action. Accordingly, the Applicant respectfully requests the withdrawal of the objection to the claims.

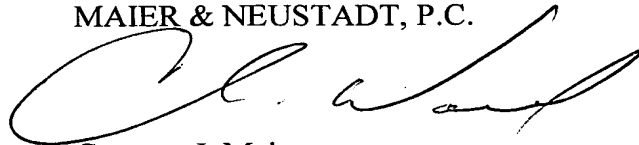
The Applicant submits that Claims 1-4 are in condition for allowance, as indicated on page 5 of the outstanding Official Action.

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Reply to Office Action dated July 28, 2005

Consequently, in view of the above discussion, it is respectfully submitted that the present application is in condition for formal allowance and an early and favorable reconsideration of this application is therefore requested.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

A handwritten signature in black ink, appearing to read 'G. Maier', written over the printed name of Gregory J. Maier.

Gregory J. Maier
Registration No. 25,599
Attorney of Record

Christopher D. Ward
Registration No. 41,367

Customer Number

22850

Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 10/01)

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29a-P9-20 SCMおよびEFM用高分解能導電性探針の作製

Fabrication of high-spatial-resolution conductive probes for SCM and EFM

関東リサーチセンター、千葉大工* 中川善樹、前田淳子、中村健一、宮元久和、谷井隆治

Toray Research Center, Inc., Chiba University*, Y. Nakagawa, R. Maeda, M. Nakamura, H. Takamoto, and Y. Tsuji

Yoshizuga_Nakagawa@trc.toray.co.jp

【はじめに】原子力顕微鏡(AFM)を用いた電気的測定には導電性カンテラバーが必要である。走査型キャパシタンス顕微鏡(SCM)や電気力顕微鏡(EFM)では、高い導電率を有しつつ高い空間分解能の信号が得られる金銀コート探針が通常用いられている。SCMやEFMは長距離力である電気力を用いて測定を行うために、空間分解能はチップのごく先端の三角形状だけでなく、先端付近のマクロな形状によっても影響を受ける。そこで、「電気的に見た」探針先端を小さくするために、金属を三角錐形タイプの一面にのみコートした探針を考案した。実際に探針を作製し、半導体デバイスのSCM測定を行なったところ、高空間分解能の画像を得たので報告する。

【実験・結果】市販の三角錐形のノードン/シリコンタイプをUVおよびフッ酸で処理した後、Ptを三角錐形の一面にのみコートした。この探針を用いて、DRAMの断面のSCM測定を行った。図1の90°の隅で鋭んだ領域を測定したものが図2、図3である。図2が通常SCM測定に用いる市販のCoCrコート探針の測定結果、図3が今回考案した三角錐形タイプ一面向コート探針の測定結果である。鋭い形状の健全な見方がより明確にみえていることがわかる。なお当日は、EFM(SPM)の測定結果についても報告する。



図1 DRAMの断面 dC/dV 像(10×5 μm²)



図2 CoCrコート探針の測定結果(2×1 μm²)



図3 Ptコート探針の測定結果(2×1 μm²)

29a-P9-21

多層カーボンナノチューブ探針の切断による先端形状と先鋭化

Cutting and sharpening of multiwalled carbon-nanotube probes

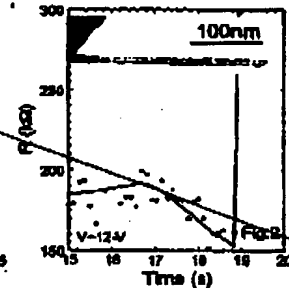
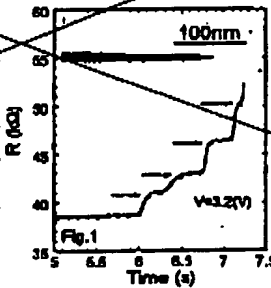
大阪府大工 〇植村秀樹、秋田成司、中山孝高

Osaka Pref. Univ., *H. Negishi, S. Akita and Y. Nakayama

akita@ed.osaka-pu.ac.jp

はじめに 多層ナノチューブ(CNT)を探針とする時、その長さや先端形状は高分解能顕微鏡には非常に重要である。本研究では、過電流によるCNT切断時におけるCNT先端の形状について検討した。

実験 導電性探針と電極の間に接続したCNTへの印加電圧を徐々に増加する。電圧変化に対し電流の変化が激しくなった時電圧一定とし、CNTが切れるまでの電流値の時間変化を測定した。実験は圧力 2×10^4 Pa以下、真空中のSEM中で行った。結果と検討 CNTと電極との接触抵抗が低い図1の場合、先端部はTEM像のように徐々に細くなり、電圧3.2Vでの抵抗の増加は急激になる。これは、CNTの最外層から一層ずつ層が剥離することを反映している。一方、図2の接触抵抗が約100KΩ以上の場合、図1とは異なりその断面は急峻で先端が鋭い。切断が始まる電流は図1.2倍の場合も-80μA程度とほぼ等しく過電流電流でのみCNTが切断されたと推定される。これより図2の場合印加電圧が12Vと高く切断された時に同CNT内で激少放電が生じ切断面が急峻になったと考えられる。従って、切断時の電流を制御し先端のみ先鋭化した理想的な探針製作に成功した。



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添付資料1

(1) "Lecture Manuscripts of 49th Applied Physics Relation Joint Lecture Meeting",
March 2002, Shonan School Building in Tokai University, pp. 687

The following is an English translation of an extract of the above document.

A conductive cantilever is necessary for electrical measurement using interatomic
5 forces microscope (AFM). For a scanning capacity microscope (SCM) and an electrical
force microscope (EFM), a metal-coated probe having high conductivity and capable of
obtaining a signal of good spatial resolution has been usually employed. Because SCM
and EFM perform measurements using electrical force which is a long-distance force,
spatial resolution may be influenced not only by a microscopic shape at an extreme edge of
10 a chip but also by a macroscopic shape near the edge of the chip. In order to reduce the
edge of the probe (in a macroscopic standpoint), the probe having one surface of a
triangular pyramid shaped chip coated with metal has been designed. After the probe
has actually formed and SCM measurement of a semiconductor device has been performed,
images of high spatial resolution has been obtained.

15 After commercially available triangular pyramid shaped non-doped silicon chip has
been processed using UV and hydrofluoric acid, one surface of the triangular pyramid
shaped non-doped silicon chip is coated with Pt. The SCM measurement of a cross
sectional surface of DRAM has been performed using this probe. Figs. 2 and 3 show
the measurement results of the area surrounded by a white square shown in Fig. 1. Fig. 2
20 shows the measurement result where a commercially available CoCr-coated probe usually
used for the SCM measurement is employed, and Fig. 3 shows the measurement result
where the probe having one surface of the triangular pyramid shaped chip coated with Pt,
which is designed, this time is employed. It is found out that a black belt-shaped
junction depletion layer can be seen clearly. On the day, the measurement results of
25 EFM (SPoM) will be reported.